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WISCONSIN STRATIGRAPHY AT PORT TALBOT ON THE NORTH SHORE OF LAKE ERIE, ONTARIO

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GENERAL PLEISTOCENE GEOLOGY

Most of the area north of Lake Erie is covered by Pleistocene deposits in thickness of 100 to 300 feet, except for both ends of the lake where bedrock is shallower. The surface drift is generally considered to be of Cary and Mankato age (Glacial Map of North America, 1945).

In order to obtain a better idea on the Pleistocene stratigraphy of the area north of Lake Erie, the writer has examined hundreds of exposures along the central portion of the lake, between Romney and Port Rowan, Ontario. A brown clayey till, interbedded and covered by lacustrine deposits, was found to be the principal material. This till is in one layer in the eastern half of the area studied, but it consists of two or three towards the west. All three till beds have similar colour, texture and lithologic composition (Dreimanis and Reavely, 1953, p. 238–239). They appear to be deposited by the same ice lobe during the oscillatory retreat. A common name, the "upper till," have been applied to these till beds because each of them is exposed on the surface farther north of Lake Erie. A similar clayey till extends also south of the lake (White, 1951, p. 971).

A deeper sandy till has been found either in exposures (Dreimanis and Reavely, 1953, p. 239) or reported by well logs through the entire area studied, and it has been called the "lower till." Similar sandy tills underlie the surface drift in northern Ohio (Shepps, 1953, p. 43).

No organic deposits or soils have been found between the upper and the lower till in Southwestern Ontario. Therefore, these two tills are considered as deposits of the last, Wisconsin, glaciation.

THE PORT TALBOT AND PLUM POINT SECTIONS

While examining Lake Erie cliffs half a mile southwest of Port Tlabot (fig. 1) in October 1951, the author and his students found a previously unknown organic layer below the lower till. In figure 2, which represents this section, the "upper till" and associated lacustrine deposits are shown as units (h), (i), (j) and (k), but the "lower till" and the related stratified drift as (e), (f) and (g); the organic gyttja layer is in (c). A still older till (a), texturally similar to the lower till (g), and a related varved clay (b) were found underneath the gyttja.

A search for more organic remains revealed wood in the till (g) at Plum Point, one mile south west of the Port Talbot gyttja exposure.

The following beds are exposed there (beginning with the top layer):

lacustrine clay, equivalent to (k) or (i) + (k) in figure 2 . . . . 25 feet
clayey "upper till," equivalent to (h) . . . . 18 feet
gravel . . . . 0–1 foot
silty "lower till," equivalent to (g), with a SE–NW and ESE–WNW fabric; drag-folds overturned towards WNW; ratio of calcite to dolomite in till

matrix: 0.7; wood was found in the middle portion of this till........10–20 feet

fine sand, probably equivalent to (d), exposed above lake level only at the S. W. side of the section.. 0–10 feet

These two exposures with organic remains have been compared with many others and, both combined, were considered as the most complete Wisconsin sections along the north shore of Lake Erie. Therefore they have been studied in great detail.

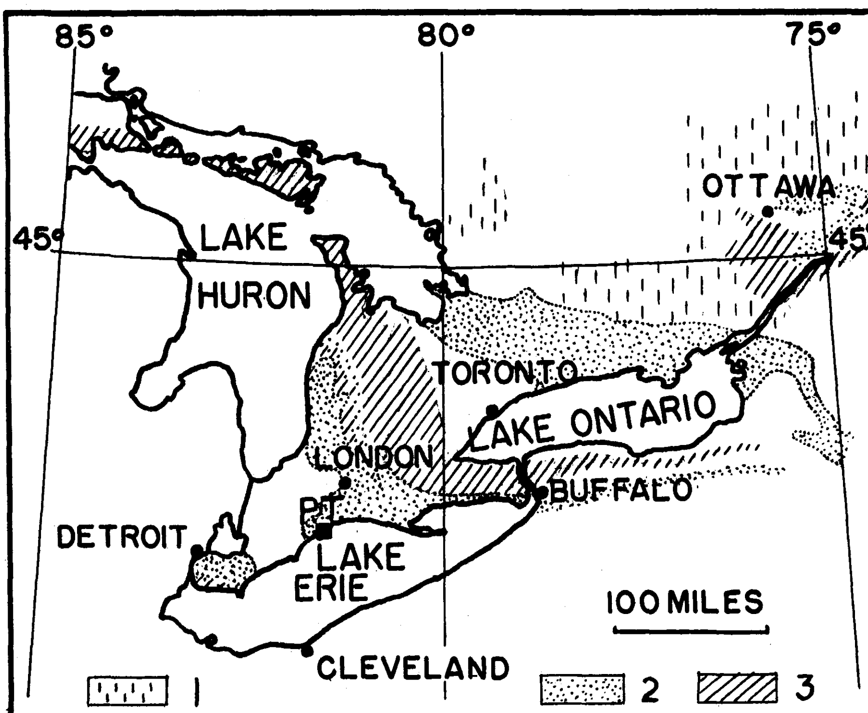

FIGURE 1. Map showing the location of Port Talbot, Ontario (P. T.) and the principal areas of carbonate bedrock:
1—scattered exposures of Precambrian crystalline limestone and dolomite,
2—Palaeozoic limestone,
3—Paleozoic dolomitic rocks.

Supplemental Information on the Port Talbot Geologic Section

A well, 103 feet above the lake level and 220 feet inland from the edge of the cliff, was drilled by A. Lather in 1955 (fig. 2 for its location). Its log (table 1) reveals at least three more till layers below the lake level.

The three foot thick layer of fine sand (depth 123 to 132 feet) may correspond to the sand (d) or silt (c) of the lake bluff on figure 2. The variance in depth of this sand (30 to 40 feet deeper than at the lake shore) may be due to folding by glacial thrust, as the layers (b) to (f) and the basal portion of the "lower" till (g) is folded, overthrusted or sheared at many places along the lake shore.

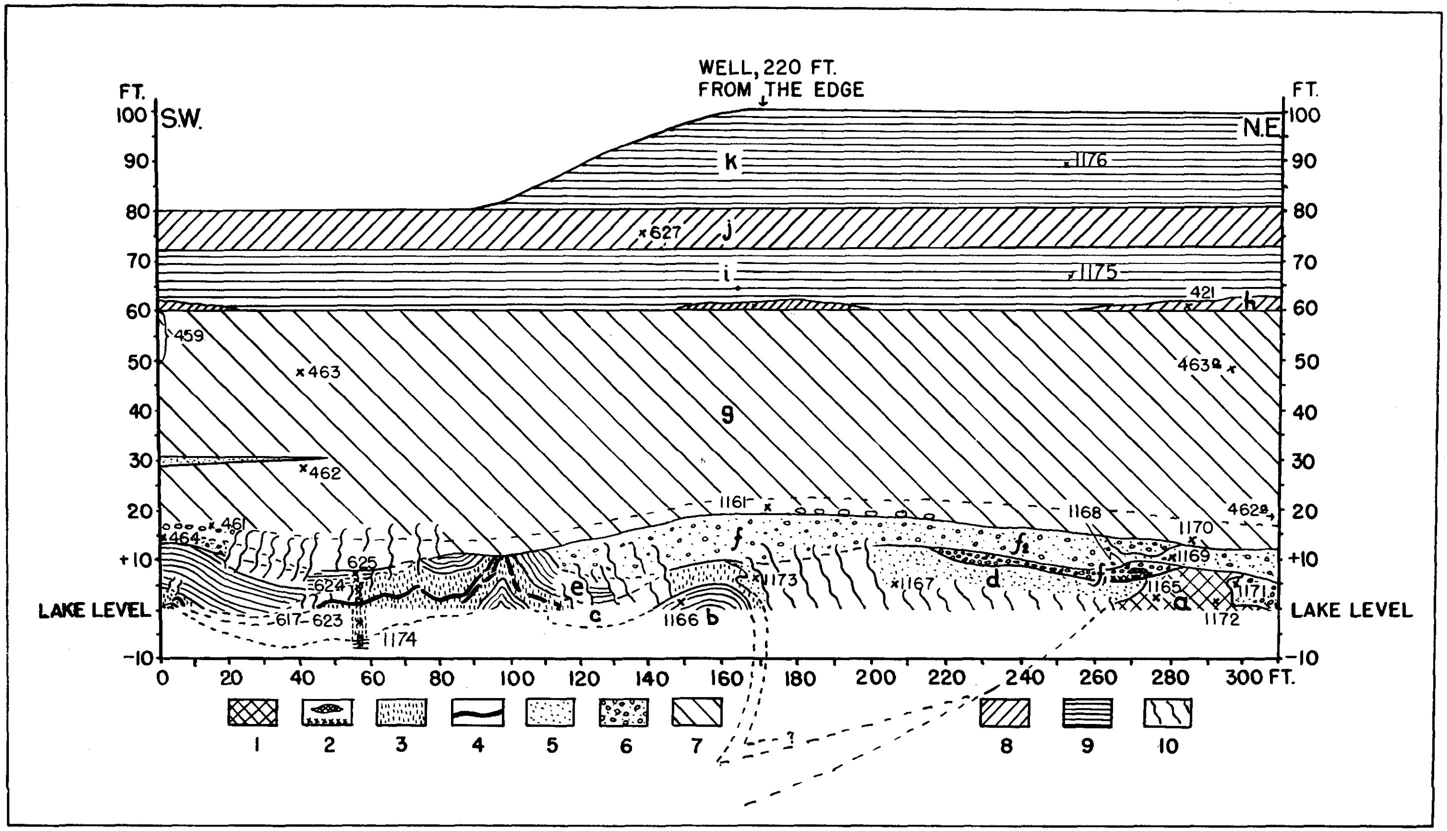

FIGURE 2. Geologic section along the lake Erie bluff half a mile SW of Port Talbot, Ontario.
Legend: 1—till (a), 2—till (f_1), 3—silt (c), 4—gyttja (c_4 and c_5), 5—sand, 6—gravel, 7—till (g), 8—"upper till" (h) and (j), 9—lacustrine clay (b), (e), (i) and (k), 10—slump, x—locations of samples and their reference numbers.

An excavation at the 56 ft. point of figure 2 and augering down to 7 feet below the lake level revealed the following details of the bed (c):

d —lacustrine clay, stratified	2 feet
- - - - - - - - - - - - - - - - - - unconformity	
c_6—silt, faintly stratified, yellow, calcareous; with a few tiny shells of molluscs	3 feet
c_5—gyttja, dark brown to dark gray, with visible plant remains and some shells of molluscs; calcareous	0.2–0.3 feet
c_4—calcareous gyttja, light gray, similar to (c_5) and grading into it, but with more calcite and more molluscs	0.2–0.3 feet
c_3—silt, stratified, yellow; with some plant remains and molluscs, calcareous	1.3 feet
- - - - - - - - - - - - - - - - - - unconformity	
c_2—silt, stratified; gray, with dark lamina, relatively rich in fine organic matter; becomes yellow when exposed to air	4 feet
c_1—sandy silt, gray	3 feet
- - - - - - - - - - - - - - - - - - unconformity	
b varved clay	at least one foot

TABLE 1

Well Log, Port Talbot interstadial site

Well log, as reported by A. Lather Thickness ft.	Depth ft.	Material	Geological Interpretation	Probable correlation with figure 2
45	0–45	Clay	Lacustrine clays and upper tills	(h), (i), (j), and (k)
84	45–129	Hardpan	Till	(g) and (f)
3	129–132	Fine sand, with water, that rose to 100 ft. below surface	Fine sand or silt	(d) and/or (c)
13	132–145	Hardpan	Till(?)	(a)
38	145–183	Gray clay	Lacustrine clay(?)	older than (a)
20	183–203	Hardpan	Till(?)	older than (a)
12	203–215	Pink clay	Lacustrine clay (?)	older than (a)
16	215–231	Hardpan	Till(?)	older than (a)
3	231–234	Dundee "big lime"	Bedrock: middle Devonian limestone, Dundee formation	

TEXTURE, LITHOLOGY, ICE-FLOW DIRECTION

Grain-size distribution, lithologic composition and till fabric has been studied in the Port Talbot area by methods described in Dreimanis and Reavely (1953). In addition, calcite was differentiated from dolomite while determining the carbonate content of silt and clay (−200 mesh fraction). Results of examinations from the section shown on figure 2 are summarized in tables 2 and 3. Supplemental information about the "upper till," equivalent to the layers (h) and (j), and the "lower till," equivalent to (f_1) and (g), may be found in Dreimanis and Reavely (1953), and Dreimanis, Reavely, Cook, Knox and Moretti (1957).

Till (a).—This is the lowermost exposed till in the area studied. It has been found only at one place (fig. 2). This till is gray and resembles the "lower till" (g). It has also a similar mechanical composition with sand and gravel dominating over silt and clay and is highly calcareous (43 percent carbonates). The till (a)

TABLE 2

Lithology of pebble and sand fractions—Port Talbot interstadial site

Reference letter	File No.	Material	Pebbles: 5–25 mm. (percentages) Ign. & Metam.	Sandstone & siltstone	Limestone	Chert	Dolomite	Shale	Coarse sand: 0.5–1 mm. (percentages) Feldspar	Mafic min.	Quartz	Sandstone & siltstone	Limestone	Chert	Dolomite	Shale	Percentage of heavy minerals in sand: 0.15–0.8 mm.	Ratios: Palaeozoic/Precambrian Pebbles	Palaeozoic/Precambrian Coarse sand	Limestone/Dolomite Pebbles	Limestone/Dolomite Coarse sand	Purple garnet/Red garnet in sand 0.15–0.8 mm. †
j	627	Second bed of	5	3	24	3	3	63										19		8		0.9–3.0
	380	"upper till"							6	2	7	4	7	2	5	67	1.4		5.7		1.4	
h	379	First bed of							5	+	7	5	9	2	4	68	1.5		7		2.3	mode: 1.0
	421	"upper till"	9	15	21	2	10	43										10		2.1		
g	459	"lower till" +40 ft.	21	2	41	9	26	1	13	8	16	7	35	2	20	1	2.35	3.8	1.7	1.6	1.8	
	463	+33 ft.	23	0	54	2	20	1		39				61			2.75	3.4	1.6	2.7		
	462	+13 ft.	25	1	45	7	22	0	15	9	22	5	31	2	17	1	3.40	3.0	1.2	2.0	1.8	0.2–1.0
	461	+ 3 ft.								45				55			3.55		1.2			
	464	+ 1 ft.							17	7	22	5	30	3	14	2	2.75		1.2		2.1	mode: 0.7
	1161	+ 1 ft.	23	0	47	1	29	0										3.4		1.6		
	1170	+ 1 ft.	17	8	46	5	24	+										4.9		1.9		
f_2	1169		18	6	42	4	22	0										4.8		1.9		
	1169a	gravel	27	5	39	2	27	1										2.7		1.5		
	1171		19	5	42	5	28	0										4.3		1.5		
f_1	1168	till	25	7	43	4	19	2	18	7	22	3	32	3	12	3	4.50	3.0	1.1	2.2	2.7	0.7
d	1167	pebbles in	19	1	29	3	46	+										4.3		0.6		
	1173	sand																				
a	1165	lowermost	22	2	34	6	36	0	19	9	29	1	21	3	17	1	3.47	3.5	0.8	0.9	1.2	0.6
	1172	till	21	3	32	9	34	1										3.8		0.9		

†Ratios quoted from Dreimanis, Reavely, Knox, Cook and Moretti (1957); they are based upon 28 heavy mineral determinations along the north shore of Lake Erie.

differs from all the later tills along the north shore of Lake Erie by a higher content of dolomite. Dolomite exceeds calcite five times in the −200 mesh fraction, but both of them are in a relatively equal amount in sand and among pebbles. Crushing of glacial drift during its transport increases the amount of rock flour with the distance from its source. Therefore, the relatively greater dominance of dolomite over calcite in the finer grain sizes of the till (a) than in its coarser components suggests a distant source, at least for some of the dolomite.

The regional trend of the ice flow which deposited this till may be concluded from the heavy mineral composition. Heavy minerals were examined by G. H. Reavely, who found their association essentially similar to that of the Erie "lower till" (g) (Dreimanis *et al.*, 1957, p. 160). The only noticeable difference was in the low percentage of garnets: 4 percent in (a) but more than 15 percent in (g). The heavy mineral content, if compared with the source areas on the Canadian shield (Dreimanis *et al.*, 1957, fig. 1), suggests that the glacier has traversed the Grenville province. Thus it must have come from the north east or north.

Extensive source areas of dolomite, required by the highly dolomitic till matrix, are along both the above ice-flow directions (fig. 1). The most distant source is the Ordovician Beekmantown dolomite of the St. Lawrence lowland. The dolomitic Silurian and Devonian rocks of Southwestern Ontario are relatively closer. As the till layer (a) has been deformed by ice pressure at the interstadial site, its fabric at this place is not reliable for deciphering the glacial movement, which existed during the deposition of the till. Additional regional lithologic and fabric studies are still necessary for final conclusions of the ice-flow direction and source areas of this till.

Layers (b), (c) and (d).—All these three layers are considered lacustrine deposits; (d) may be also fluvial. Their stratigraphic sequence is most completely exposed in the central portion of figure 2. The varved clay (b) may be seen also in other places along the water level of Lake Erie. Its varves are approximately one inch thick, and they have been faulted considerably, probably by glacial pressure.

The bed (c) consists of very calcareous silt (50 percent carbonates) with a lens of gyttja in the middle. The gyttja layer is doubled along the west limb of the fold at 90 to 100 feet mark (fig. 2). As both the gyttja and silt are sheared at this place, the doubling may be considered a secondary feature, caused by glacial thrust from the south.

The sand layer (d) is well sorted, fine to medium grained and stratified. It contains some pebbly streaks. The pebble content is similar to that of the till (a), with an even higher amount of dolomite.

All the layers (b), (c) and (d) have a similarity in their lithologic composition with the underlying till (a). They are rich in dolomite in the −200 mesh fraction, (the ratio of calcite to dolomite: 0.1 to 0.3), with one exception: the calcareous gytta (c_4), where some calcite is of organic origin (produced by *Chara*). Similar ratios of calcite to dolomite in all the successive layers from the till (a) to sand (d) suggest that the principal source of the detrital material of the stratified drift in (b), (c) and (d) was the unweathered till (a). Another support for the derivation of (d) from (a) is their similarity in the pebble composition.

Lacustrine clay (e).—The next layer (e) is a stratified lacustrine clay without any distinct varving in the exposure, shown on figure 2. Varves are present in some of its portions closer towards Plum Point. Though the grain-size composition of the clays (e) and (b) is similar, they differ in their carbonate content: the ratio of calcite to dolomite of (e) is three times higher than in (b). This ratio is similar to that of the overlying tills (f_1) and (g). The lacustrine clay (e) was deposited in a lake that received muddy waters from the advancing glacier, which deposited the till (f_1) later on.

Clayey gravel (f_2) with reworked till (f_1) at its base.—This covers the folded layers of (a) to (d), except for a 60 foot long interval in figure 2. Here it has

TABLE 3

Mechanical composition, carbonate content of the −200 mesh fraction and till fabric Port Talbot interstadial site

Reference letter	File No.	Material	Mechanical composition (percentages) sand	silt	clay	Carbonate content in silt and clay fraction (less than .074 mm.) percentages total	calc.	dol.	calc./dol.	Local ice flow direction during deposition of till: average of several measurements along a one mile long exposure between Plum Point and Port Talbot
k	1176	lacustr. clay	11	55	34	34	18	16	1.1	
j	627	second bed of	17	36	47	33	16	17	.9	from ESE (pebble
	380	"upper till"	39	48	13	33	16	17	.9	alignment)
i	1175	lacustr. clay	10	56	34	36	18	18	.8	
h	379	first bed of	12	29	59	32	16	16	1.0	from SE (striae on boulders along
	421	"upper till"	27	28	45	32	16	16	1.0	the base of till)
g	459	"lower till" +40 ft.	64	21	15	39	17	23	.7	from ESE (pebble
	463	+33 ft.	68	18	14	38	17	21	.8	alignment)
	462	+13 ft.	70	18	12	40	16	24	.7	from NE (pebble alignment)
	461	+ 3 ft.	69	25	6	40	17	23	.7	from E (pebble alignment)
	464	+ 1 ft.	62	21	17	37	17	20	.9	from SE (striae on
	1161	+ 1 ft.	55	26	19	39	16	23	.7	boulder accumu-
	1170	+ 1 ft.	66	22	12	38	13	25	.5	tions)
f_2	1169	dirty gravel	89	5	6	37	17	20	.8	
f_1	1168	till	47	21	32	38	18	20	.8	from S. (drag-folds, pebble alignment)
e	625	lac. top	5	39	56	41	15	26	.6	
	624	clay base	8	23	69	40	16	24	.7	
d	1173	fine sand	88	12	0	35	9	26	.3	
c_6	623	silt top	14	74	12	50	6	44	.1	
	622	middle	22	60	18	49	6	43	.1	
	621	base	18	78	4	50	7	43	.2	
c_5	619	dark gyttja				14	2	12	.2	
c_4		light gyttja				24	9	15	.6	
c_3	618	silt	14	82	4	50	6	44	.1	
c_2	617	silt	16	81	3	49	6	43	.1	
c_1	1174	sandy silt	40	59	1	42	8	34	.2	
b	1166	varved clay	4	26	70	44	8	36	.2	
a	1165	till	60	26	14	43	7	36	.2	

been cut off by the overlying till (g). Most pebbles are subangular in the gravel (f_2). Voids between them are filled with clay, silt and sand; some pebbles seem to be wrapped in a clayey matrix.

This gravel was deposited by a very muddy water, or even by mud flows with a short-range transport. It is probably an ice-contact deposit. Similar interbedded gravel, cobble accumulations and till have been observed along the base of the "lower till" (g) and previously considered as its basal portion (Dreimanis and Reavely, 1953, p. 255). Lithologically, the layer (f) is similar to (g) (tables 2 and 3), but an erosional contact separates them (fig. 2). The till (f_1) is also more clayey than (g) at the gytta exposure. Occasional organic remains (see farther) have been found in both (f_1) and (f_2).

The till (f_1) has been deposited by an ice flow from the south (from the Lake Erie basin) as indicated by till fabric and ice-thrust deformations, particularly drag-folds in this till and underlying deposits, overturned towards the north. Most of these evidences have been gathered outside of the gyttja exposure, but some of the folds may also be seen in figure 2. The source of the till (f_1) will be discussed together with (g).

The olive gray sandy "lower till" (g).—This is the most prominent layer in the exposure studied. It is also interbedded with gravel, particularly near its base (below the dashed line in fig. 2). Accumulations of boulders, resembling boulder pavements, appear at several places in this basal portion. They are discontinuous, always *in* till and do not mark any subaerial surfaces. Their formation has been discussed in Dreimanis and Reavely (1953, p. 243–244).

Lithologically, the tills (g) and (f_1) are characterized by a high content of carbonates with a dominance of limestone, except for the −200 mesh, where the ratio of calcite to dolomite is around 0.7. The dolomite ratio to calcite increases with decrease of the grain-size, but not as much as in the lowermost till (a). The considerably lower amount of dolomite in the till matrix of (g) and (f_1) distinguishes them from the till (a). Occasional boulders of Precambrian tillites and marble have been found in this till (but not in the "upper tills").

The local ice-flow direction, deciphered from the till fabric and by statistical studies of striae on boulder accumulations in (g), has been first from SE, later on from E, then from NE and finally from ESE again. These changes in glacial movements have been gradual during the deposition of the basal till (g) (see table 3 for a summary; a detailed account on these directional studies will be given in a separate paper). Heavy mineral investigations (Dreimanis *et al.*, 1957, p. 160), together with the carbonate content in the till matrix, suggest that the regional movement of the glacier, which deposited the "lower tills" (g) and (f), was from north-northeast across the area north of Lake Ontario, missing most of the Ordovician dolomites between Ottawa and St. Lawrence.

Two layers of the "upper till" (h) and (j).—Each is followed by lacustrine clay (i) and (k) in the alphabetic order, and they fill the top portion of the exposure. All these four layers are pale brown and rich in clay and silt (except for sample No. 380, representing a reworked till). The pale brown colour probably is from the Queenston shale, picked up by the glacier at the base of the Niagara escarpment and crushed during transport. Occasional fragments of this reddish brown shale are found in the tills (h) and (j). The clay fraction of the gray tills (a), (f_1) and (g) is also brownish, indicating a common source of their matrix with the "upper till." As the "upper tills" are more clayey, the brown colour dominates in them more than in the sandy older tills. The total carbonate content in matrix of the "upper tills" is less than in the "lower," particularly because of a decrease in the amount of dolomite. The carbonate percentage is particularly low in the sand and pebble fractions.

Shale (mostly gray, some black) is the principal constituent of these coarser fractions and range as high as 63 percent. The gray calcareous and black noncalcareous shales derive from the local Middle Devonian rocks in the Lake Erie depression. The dominance of local material results also in a very high ratio of Paleozoic to Precambrian rocks (6–19) in (h) and (j), much higher than in the older tills (1–5). A lower percentage of heavy minerals in the "upper till" (1.4 to 1.5 percent), if compared with the earlier tills (2.35 to 4.50 percent), is another proof of a lesser admixture of Precambrian material in the "upper tills."

The ratio of purple to red garnets is slightly higher in the "upper tills" (h) and (j) than in the lower ones (a), (f_1) and (g). According to Dreimanis *et al.* (1957), such a ratio, together with a high ratio of tremolite-actinolite to chlorite-serpentine, suggests a regional glacial movement from Labrador over the Grenville rocks northwest of Montreal, but avoiding the Ottawa-St. Lawrence dolomite area and moving probably west of it, as indicated by a relatively low amount of dolomite in till matrix. Local centres of glacial outflow may have existed in the Lake Ontario (Holmes, 1952, p. 1006) and Lake Erie Basins (Dreimanis and Reavely, 1953, p. 254), during deposition of the "upper tills," as suggested by a very strong erosion and outward transport of local rocks from these lake depressions.

The upper tills (h) and (j) contain also pebbles of lacustrine clays. They, together with the dominant clay and silt fraction of the till, must have been derived from preexisting clay deposits, younger than the lower sandy till.

Carbonate content of the lacustrine clay (i) is intermediate between the "lower till" (g) and the "upper till" (h, j). Apparently the melt-water streams from the glacier which deposited the "upper till" were not the only source of clay and silt; a considerable amount has been added from the reworked surface of the "lower till."

ORGANIC REMAINS

Ostracods.—Ostracods were found by Staplin (1953, pp. 86–88) in the layers c_3 to c_6 (Staplin's locality QW–31, samples A, B and C). The following species were determined by him: a) in c_6 (sample C)—*Candona ohioensis*, *Candona parachioensis* n. sp., (?)*Candona simpsoni*, *Cyclocypris forbesi*, *Limnocythere verrucosa*, *Cypridopsis vidua*; b) in c_4 (sample B)—*Limnocythere verrucosa* and fragments of other ostracods; c) in c_3 (sample A)—*Candona candida*, *Candona truncata*, *Candona simpsoni*, *Candona* spp., *Limnocythere trapeziformis* n. sp., *Limnocythere verrucosa*, *Cyclocypris ovum*, *Cyclocypris forbesi*, *Potamocypris variegata*, *Cypridopsis vidua*.

Staplin concludes from his findings, that "ostracods in the lower silt (c_3, A. D.) probably lived in the shallower weedy parts of the lake. A lowering of water level and the initiation of highly vegetated marsh conditions is indicated by the middle organic silt. Deepening of the water, at some later date, formed the upper layer (c_6, A. D.). *Candona ohioensis*, present only in the upper silt, now inhabits the Lake Erie's shallower parts. *Limnocythere trapeziformis* n. sp., abundant in the lower silt, is common in Mankato deposits of the Chicago region, occasional in the Sappa silt of Iowa, and unknown elswhere."

Molluscs.—Molluscs are common in the beds c_{2-6}. As the fragile shells have been crushed by glacial pressure, most of them disintegrated completely during removal from the compacted silt. A bulk sample of c_4 was sent to Dr. W. J. Wayne at the Geological Survey of the State of Indiana, but he experienced the same difficulties in extracting the shells. After having washed 20 pounds of silt, he succeeded only in recovering some specimens of *Valvata cf. V. lewisi Currier*, fragments of *Gyraulus*, probably *G. parvus*, both inhabitants of shallower water in the Great Lakes region and north of it, and a small species of *Pisidium* (personal communications).

Mastodon.—A well preserved middle portion of a tusk, one foot long and three inches in diameter, with sharply broken ends, was found in the clayey bouldery gravel (f_2) 600 feet north east of the N. E. end of section, shown on figure 2. Lack of any marks of glacial or stream abrasion suggest a very short transport.

Plant remains other than pollen grains.—Fruits and seeds were found abundantly in the gyttja layers c_4 and c_5. According to Dr. J. Terasmae, Geological Survey of Canada, most of them belong to *Najas flexilis* (Willd.) Rostk and Schmidt, with some *Potamogeton gramineus* L. and *Menyanthes trifoliata var. minor* Raf. Dr. H. Müller, from the Amt of Bodenforschung, Hannover, examined specimens, shown to him by Dr. W. J. Wayne. He found fruits and seeds of *Najas cf. flexilis, Potamogeton cf. filiformis* and *Potamogeton cf. alpenis* (personal communications). L. Staplin (1953, p. 87) mentions also "much *Chara*" in his sample B, equivalent to

TABLE 4

Length of bodies of Pinus sp. *pollen grains, Port Talbot interstadial*

	Total number counted	Number of pollen grains at an average body length of										
		26μ	30μ	34μ	38μ	42μ	46μ	50μ	54μ	58μ	62μ	66μ
Upper silt (C_6)	81	–		14		*60*			6		1	–
Gyttja (C_5)	39	–	–	3	7	*23*	3	3	–	–	–	–
Calcareous gyttja (C_4), upper ⅔	25	–	1	2	5	*10*	5	2	–	–	–	–
Calcareous gyttja (C_4), lower ⅓	32	–	1	2		*7*	7	5	7	5	1	–
Lower silt (C_3) 1 ft. below gyttja	45	–	–	6		*18*		5			*10*	6
Lower silt (C_2) 2 ft. below gyttja	83	1	3	6	20	*24*	17	8	4	–	–	–
Lower silt (C_2) 3 ft. below gyttja	69	–	1	6	9	*31*	14	4	2	1	1	–
Lower silt (C_2) 4 ft. below gyttja	41	–	1	5	*15*	*15*	3	2	–	–	–	–
Lower silt (C_2) 5 ft. below gyttja	51	–	1	4	11	*22*	13	–	–	–	–	–
Lower silt (C_2) 5¾ ft. below gyttja	41	–	1	2	14	*21*	3	–	–	–	–	–
Sandy silt (C_1) 7 ft. below gyttja	12	–	–	–	5	*7*	–	–	–	–	–	–

the lower portion of gyttja (c_4). All the above plants grow in shallow, mostly calcareous waters, either in the Lake Erie basin or farther north at present. A compressed fragment of spruce root (*Picea* sp., determined by the Forest Products Laboratories, Ottawa) was found in lacustrine clay (e) 1000 feet S. W. of the gyttja exposure. Unidentifiable megasocpic plant remains (compressed stems and fragments of leaves) were relatively abundant in the till (f_1) at the 270 foot mark of figure 2, and a splinter of Gymnosperm wood was found together with the mastodon tusk in (f_2). Pieces of larch and spruce wood (*Larix* sp. and *Picea* sp., according to the Forest Products Laboratories) were discovered in the "lower till" (g) one mile S. W. of the gyttja exposure at Plum Point.

Pollen analysis.—This was applied in order to find out the climatic conditions prevailing during the depositions of the layer (c).

The ordinary KOH method was used for digestion of organic remains other than pollen grains. Carbonates were dissolved in dilute cold hydrochloric acid and silicates in cold hydrofluoric acid before applying KOH. Pollen grains were stained with basic fuxin and methilene blue. An average of 250 tree pollen grains was counted in each sample, except for the lowermost one, which rendered only 54 tree pollen grains.

Percentage of the non-tree pollen grains (NAP), including shrubs, like willow (*Salix*), was calculated by assuming the sum of the tree pollen grains as 100 percent. Most of the NAP were pollen of *Gramineae* (grasses).

The relative frequency of tree pollen grains in samples, or the so-called arboreal pollen frequency (APF) was determined arbitrarily: as the number of pollen grains per one 16 x 16 mm. slide. Such APF values are not suitable for comparison with results of other palynological studies, but they may give some idea on the frequency changes in this Port Talbot profile. Thus, the lowermost sandy

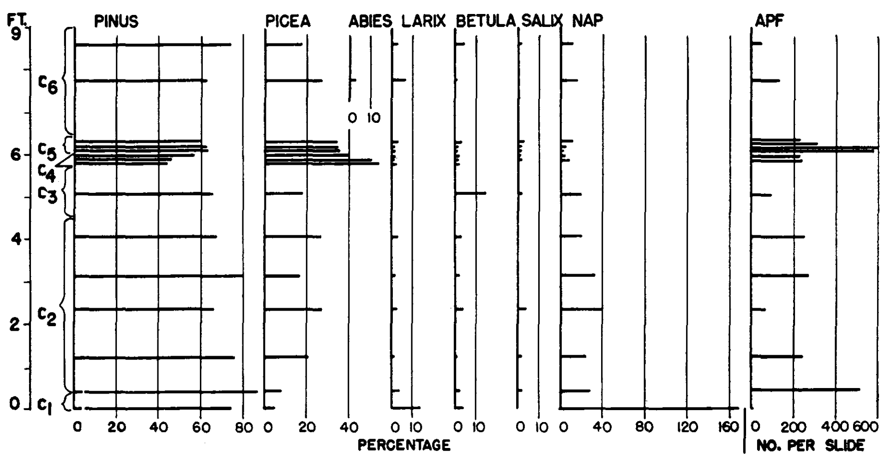

FIGURE 3. Pollen diagram of the Port Talbot interstadial section (c_1) to (c_6). NAP—non-arboreal pollen. APF—number of arboreal pollen grains per slide.

silt (c_1) has a much lower APF value (11) than other samples above it. NAP (168 percent) dominate over the tree pollen in the same sample. Both the low APF and high NAP values suggest that probably no forests existed along the northern shore of Lake Erie at that time. The tree pollen grains, found in this sample, may have been carried in by wind from the area south of Lake Erie.

The considerable variation of the APF values (42 to 620 percent, mostly over 200 percent, fig. 3) in other samples of the layer (c) may be due to the different characters of the sediments examined and various rates of admixtures of other organic remains. Thus, some samples rich in organic remains other than pollen have lower APF values. The low NAP percentage of the same samples (15 to 40) suggests a forest growth in the vicinity. This conclusion is supported also by a twig, found in (c_4).

Results of the pollen analysis (fig. 3) suggest that the following trees have grown along the north shore of Lake Erie during deposition of the layer (c): pine (*Pinus* *sp.*), spruce (*Picea sp.*), larch (*Larix sp.*), birch (*Betula sp.*). Pollen grains of balsam fir (*Abies sp.*), elm (*Ulmus sp.*) and alder (*Alnus sp.*) were found to be less than 1 percent (except for 3 percent of fir in c_6), and their presence does not necessarily mean that the corresponding trees grew in vicinity. Wind transport from great distances or redeposition from older layers may be the explanation.

The length of the bodies of the pine pollen grains (between the outer points of the insertion of the bladders) was measured in nearly all slides (table 4). Results of these measurements group around two maxima: a) about 42 μ and b) 54 to 64 μ. The smaller size (42 μ), which dominates through most of the section, compares well with jack-pine (*Pinus Banksiana* Lamb., length of the body 41 to 48 μ) in Cain's (1940, p. 303) study of recent and fossil pollen grains. The larger pollen grains of pine, with bodies 54 to 64 μ long, are found particularly along the contact of the lower silt (c_3) and the calcareous gyttja (c_4). They may belong to the white pine (*Pinus strobus* L., bodies 55 to 60 μ long according to Cain) or the red pine (*Pinus resinosa* Ait., 55 to 64 μ), common trees in the Great Lakes region.

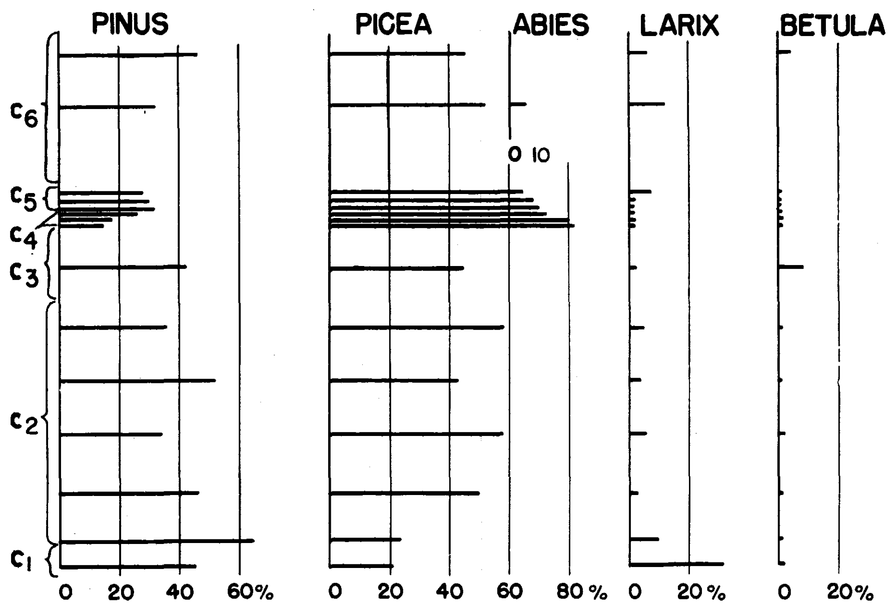

FIGURE 4. Recalculated pollen diagram of the Port Talbot interstadial section, with the numbers of *Pinus* and *Betula* pollen grains reduced four times.

It is possible that the larger pollen grains of pine (54 to 64 μ) include also other species of *Pinus* than *P. strobus* and *P. resinosa.*

Pollen grains of the same three species, measured by Deevey (1939, p. 696) are smaller: *Pinus Banksiana*: 28 to 56 μ, mostly about 37 μ; *Pinus strobus*: 41 to 55 μ, mostly about 48 μ; *Pinus resinosa*: 36 to 53 μ, mostly 42 to 48 μ. The relative size relationship between *P. Banksiana* and the other two species of pine remains the same. Differences in size measurements by Cain and Deevey may be caused by differences in treatment during the pollen analysis.

Pines and birches produce more pollen than most other trees, such as spruce. Therefore, the percentage of pollen grains of pine and birch have been reduced four times on figure 4, following suggestions by Faegri and Iversen (1950, pp. 87–88). That is done in order to obtain more adequate representation of the actual composition of forests. The true association of forest trees was probably still different than that of the recalculated diagram, as we do not know the exact amount of productivity of various pollens. Another unknown factor is the percentage of poplar (*Populus sp.*), one of the most abundant recent forest trees in northern Canada, as its pollen grains do not preserve well.

The recalculated pollen diagram suggests a relatively equal abundance of pine and spruce during the deposition of the lower silt. A strong spruce maximum is at the base of gyttja (c_4) (immediately above the maximum of pines with the large pollen grains), and spruce still dominates through the gyttja and the upper silt, though gradually becoming less abundant. Pollen grains of larch (*Larix sp.*) are most abundant (10 to 12 percent) at the base of the lower silt and in the upper silt. Birch (*Betula sp.*) reaches its highest abundance (9 percent) in the silt one foot below the gyttja.

The Forest Research Division of the Department of Resources and Development at Ottawa was consulted regarding recent forests, similar to those represented by the pollen diagram of figure 3. Dr. J. D. B. Harrison, Chief of the Forest Research Division, answered that "extensive forests having a similar composition, with the exception of *Larix*, can be found today in the valleys around Gouin Reservoir at the headwaters of the St. Maurice River in Quebec." Climate of the Gouin reservoir area (48.5°N, 74°W) is with cold winters (January temperature slightly above zero) short, but relatively warm summers (mean July temperature 68°). The year has only 80 frost free days, as compared with 160 at the north shore of Lake Erie at present (Putnam, 1952, pp. 132–133, 222–223). Climatic conditions, similar to those described above, have probably existed along the north shore of Lake Erie during the deposition of most of the layer (c). Admixture of *Pinus* pollen grains belonging to another species than jack-pine (probably *P. resinosa* or *P. strobus*), at the end of deposition of the lower silt (c_3) suggest that the climate became slightly warmer at that time. The later decrease in size of *Pinus* pollens in the upper layer (c_{4-6}) indicates a cooling of the climate again.

Pollen grains were examined also in the till (f_1)—sample No. 1168, as it was rich in plant remains. The APF was found to be very low (20) and so also the NBP (30 percent). Pine dominated among the arboreal pollen (70 percent), with spruce and birch as the next most common trees (13 percent of each). The pollen grains of pine were of two sizes: a half of them with the length of body 40 to 48 μ, and the other half, 54 to 64 μ, the same as in layer (c). Except for one pollen grain, that looked like oak, and another of alder, all the other pollen grains were the same as in the layer (c). The two pollen grains of deciduous trees other than birch are not sufficient to conclude existence of warmer climatic conditions than represented by the interstadial layer (c). As no other tills separate the (c) from (f_1), a conclusion may be drawn that the secondary pollen grains in till (f_1) do not indicate any warmer climate during the preceding interstadial than suggested by the Port Talbot pollen diagram.

RADIOCARBON DATES

Samples of gyttja (c_5) and evergreen wood, found 1 mile S. W. from the gyttja exposure at Plum Point, have been submitted for C_{14} dating to various isotope laboratories. The first radiocarbon date of gyttja (10,900 ± 400 yrs.), published in an abstract of a paper presented at the Geological Society of America meeting at Toronto (Dreimanis, 1953, p. 1414) later turned out to be erroneous.

Later C_{14} datings are listed in table 5.

Radiocarbon dates of the gyttja (c_5) represent only its minimum age, and the apparent variations in the figures are due to the instrumental range. If the oldest age is considered as the most reliable, the gyttja was deposited more than 39,000 years ago.

The three dates for the wood fragments, found in the lower till at Plum Point, are at least 11,000 years younger. They range from 24,600±1600 to approximately 28,000 years before present. The latest date may mean the approximate time of ice advance that deposited the "lower till" (g), and it agrees well with the age of the buried Cleveland wood: 24,600±800 years (Suess, 1954, p. 469: W–71).

A question may arise as to what happened during the interval of more than 14,000 years between the deposition of the gyttja (c_5) and the till (g). Answers will be attempted on pp. 80–81.

It may be mentioned here that the time interval involving deposition of the "lower till" (g) and the first layer of the "upper till" (h) was less than 12,000 years. This figure is based upon the 24,600±1600 years radiocarbon age of the spruce wood in the till (g) and the 12,600±440 date of driftwood (McCallum, 1955, p. 34, sample No. S–25) from lacustrine spit gravels at Ridgetown, Ontario. This wood was found by Mr. A. Wade in 1954, 32 feet below the surface and immediately above the upper till, equivalent to (h). As the finder had kept the driftwood in a water barrel for a couple of weeks, contamination of the log by recent microorganisms was feared. Therefore, only the core of the log was sent for radiocarbon analysis. If the core were also contaminated, its C_{14} date may be

TABLE 5

Radiocarbon dates

Sample	C_{14} age	Laboratory Reference
Gyttja from the interstadial deposit near Port Talbot, Ontario, collected in Autumn 1951 (185A) and Autumn 1953 (W-100, S-7 and 217A)	greater than 32,000	U. S. Geological Survey, No. W-100, H. E. Suess, 1954, p. 471.
	greater than 25,000	Dept. of Chemistry, Univ. of Saskatchewan, No. S-7, K. J. McCallum, 1955, p. 34.
		Lamont Geological Observatory, W. Broecker, 1957.
	greater than 38,000	No. 185A
	greater than 39,000	No. 217A
Larchwood, from the "lower till" at Plum Point, Ontario collected in Autumn 1952, divided in two portions for C_{14} age determination	28,200±1500	Lamont Geological Observatory, No. 185B, W. Broecker, 1957.
	27,500±1200	U. S. Geological Survey, No. W-177, M. Rubin and H. E. Suess, 1955, p. 485.
Spruce wood, from the "lower till" at Plum Point, collected in Spring 1953	24,600±1600	Lamont Geological Observatory, No. 217B, W. Broecker, 1957.

slightly later than its actual age. Driftwood, collected by G. W. White at Cleveland, Ohio, from a "stratigraphic horizon between deposits of Lake Arkona and Lake Whittlesey," was dated 13,000±500 years old (Suess, 1954, p. 469, No. W–33). If the possible contamination of the Ridgewood log is considered, it may be regarded as a Lake Arkona deposit. Without contamination it may be of an early Lake Whittlesey age.

STRATIGRAPHIC CORRELATIONS AND SEQUENCE OF EVENTS

It is not safe to base stratigraphic correlations upon one single Pleistocene exposure, like the one described in this paper. Therefore, the writer has also used results of studies of Pleistocene deposits elsewhere in Southern Ontario for crosschecking, even if they have not been described in this paper.

The following sequence of events is proposed by this comparative study, with an emphasis on the Port Talbot and Plum Point sections (see also Dreimanis, 1957, pp. 166–168):

1) Advance of an ice lobe either a) from north east along the St. Lawrence lowlands, Lake Ontario and Erie or b) from the north via Georgian Bay, and deposition of the till layer (a). The "early" Wisconsin tills, which underlie the buried soil at Sidney, Gahanna, and other places in Ohio (Goldthwait, 1957; Forsyth and LaRocque, 1956, p. 1696), were deposited probably during the same subage. This glacial advance is correlated with the yet unnamed early Wisconsin glaciation, concluded by Flint and Rubin (1955, p. 9), and Goldthwait (1957) from radiocarbon dates. Flint (1956, p. 285) calls it also a post-Sangamon and pre-Wisconsin glaciation. It seems to correspond to the early Würm subage in Europe (Woldstedt, 1956, p. 84) and may be called the Early Wisconsin here.

2) When the early Wisconsin glacier retreated towards the north-east end of Lake Erie, its basin became occupied by a proglacial lake. The lake level was higher than at present, because the eastern outlet across the Niagara escarpment was blocked by the glacial ice. The varved clay (b) was deposited in this lake.

3) Further retreat of the glacier towards the north-east opened a lower outlet for the Lake Erie depression, comparable to the present Niagara gorge.

The buried St. David's channel (Spencer, 1907, pp. 133) which trends from Whirlpool of the present Niagara gorge towards north west may have been formed during this interstadial. Wood of white spruce has been reported by Spencer (pp. 133–134) 186 feet deep in the drift that fills the St. David's gorge. White spruce is considered to be one of the most northerly growing trees in Canada and fits well in the climatic conditions of the Port Talbot interstadial. The lake level was first lower than the present one, as the surface of the Niagara peninsula had been depressed by the glacial load, and the rise of land was slow and gradual after retreat of the glacier. The lower silt (c_1–c_3) and gyttja (c_4–c_5) were deposited in shallow near-shore waters of this predecessor of Lake Erie or in a small lake marginal to Lake Erie. The original position of the layers (c_1) to (c_5) must have been below the present lake level, as they have been folded above it by a later glacial thrust.

No forests bordered the north shore of Lake Erie at the beginning of (c_1), but spruce, jack-pine, larch and birch began to grow soon. As the climate improved, pines with larger pollen grains (probably red and white pine) immigrated at the end of deposition of the silt (c_3), disappearing however soon again. The transitional zone from (c_3) to (c_4) with the spruce maximum and presence of pines also other than *Pinus Banksiana* is considered as the thermal maximum of the interval between deposition of the tills (a) and (f_1). This thermal maximum was cooler than the present climate along Lake Erie. Therefore, the term *interstadial* rather than interglacial seems to be appropriate for this interval.

A similar but more extensive peat layer with plant remains indicating cold, moist climate and freshwater environment have been found in the St. Lawrence lowlands at St. Pierre, Quebec, between Montreal and Quebec City (Gadd, 1953, p. 1426). The radiocarbon date (11,050±400) mentioned in the above paper, turned out to be erroneous. The later determinations (Rubin and Suess, 1955, p. 485: W–189; Preston *et al.*, 1955, p. 958: Y–242, Y–254, Y–255, Y–256) of this and other peat beds in the vicinity gave much greater ages: >30,000 or >40,000.

A cold climate peat ball in gravel, with pollen grains of spruce and pine, older than 34,000 years (W–194), has been found at Amber, near Toronto, Ontario (Dreimanis and Terasmae, 1956, pp. 8–9 and 20–21). Matrix of the underlying till is also richer in dolomite than the two tills above the gravel, suggesting that it was deposited by an ice flow from northeast across the Ordovician dolomite area (p. 9). This dolomitic till may be correlated with till (a) of Port Talbot.

If all the above cold climate peats belong to the same interstadial as the Port Talbot gyttja, the lake Ontario basin and the St. Lawrence lowlands were not covered by a glacier at that time. How far the ice-sheet retreated in Labrador is still unknown.

As the maximum of the Port Talbot interstadial was more than 39,000 years ago, more elaborate methods of radiocarbon datings and other isotope studies have to be applied in the future for finding a closer absolute date. Some of the recent studies on climatic indications and ages of extraglacial ocean and lake deposits (Hough, 1953; Suess, 1956; Ericson *et al.*, 1956; Clisby and Sears, 1956) suggest that the above cool and relatively long interstadial interval may have existed approximately 45,000 or even 70,000 years ago.

Duration of the interstadial time may be inferred from the depth of leaching in buried soils of this interval. Flint and Rubin (1955, p. 652) have concluded that the 48 inch leaching at Sidney, Ohio, represented 16,000 years. Goldthwait (1957) arrives at even smaller figures: 5 to 15 thousand years. The available radiocarbon dates permit a longer interval.

Many evidences have been gathered in Central and Western Europe on a similar long and moderately warm interstadial, that separated the early Würm or Würm I from the main or middle-Würm (Woldstedt, 1956, pp. 82–83). As the climate of this interstadial was temperate and not cold, some authors have considered it as an interglacial (see Zeuner, 1954; and Gross, 1956, pp. 87–101 for a detailed discussion). Gross (1956, p. 97) estimates that this so-called Göttweig interstadial had lasted for approximately 15,000 years, ending 23,000 radiocarbon years ago. There are some other radiocarbon dates from Belgium (a peat lens at Godarville, older than 36,000 years, according to Rubin and Suess, W–173: 1955, p. 486) and in Holland (North East Polder, Nos. 530–534 Gröningen: from 39,200 ±1500 to more than 55,700 years, according to DeVries *et al.*, 1956) that suggest an earlier beginning of the interstadial than 23,000+15,000 years ago. It should be mentioned that the North East Polder peat is generally considered as belonging to the Eemian (=Sangamon) interglacial, but its relatively late radiocarbon ages suggest that it was deposited during an early Würm (=Wisconsin) interstadial.

4) Accumulation of gyttja was interrupted by deposition of the upper silt (c_6), and sand was laid down on the silt, probably by a lake current. These are indications of a rise of water, that may have been caused by a gradual uplift of land in the Niagara outlet area. Spruce decreased and jack-pine increased in abundance in the nearby forests.

5) The lake level rose considerably during the deposition of the lacustrine clay (e), because of blocking of the lake outlet by an advancing glacier. Muddy waters from the glacier were the principal source of the clay and silt of (e).

6) The glacial lobe that entered the Lake Erie depression from the north east spread out radially from the lake bed, thus overriding the north shore from the south and depositing the till (f_1). This glacial advance terminated the long interstadial which had its thermal maximum more than 39,000 years ago. What concerns the time of this advance, the writer considers two possibilities:

a) One of them is that deposition of till (f_1) initiated a long lasting major glaciation (see also Flint and Rubin, 1955, p. 657), beginning approximately 25,000 years ago in the Lake Erie area. In such a case (f) is merely the basal member of the "lower till" (g) and the unconformity between (f) and (g) has been caused by change in glacial movement or local oscillations.

b) Another possibility is that deposition of till (f_1) was much earlier than 25,000 years ago. It represented an ice advance separating the Port Talbot interstadial (>39,000 years old) from another ice-free interval. This hypothesis is suggested by the more than 12,000 years wide gap between the "old group" and the "middle group" radiocarbon dates (Flint and Rubin, 1955, pp. 657–658) including the new Plum Point date of 28,000 years, by absence of any "middle group" dates in the area north or north-east of Southwestern Ontario, and because of finding the Plum Point wood not in the till (f_1), but in the next higher layer (g). If this hypothesis is correct, the Main Wisconsin glaciation began to affect the Great Lakes region considerably earlier than 25,000 years ago. Its first advance which deposited the till (f_1) may have not reached south beyond Lake Erie, and it was probably short, followed soon by a retreat towards the north east. Evergreen forests returned in the Lake Erie region, at least 28,000 years ago or probably before that, but absence of similar evidences from the areas north of Lake Ontario and in St. Lawrence lowlands suggests that the ice may have remained there or at least in the vicinity. The lake shore in the Erie depression must have been farther south than at present, as the larch and spruce wood, found in till (g), has been transported from south east. The short above glacial advance into the Lake Erie basin may have had little influence on the climate farther south of Great Lakes, and an uninterrupted long interstadial interval existed there, terminating 25,000 years ago, or even later.

More facts, particularly radiocarbon dates are needed to check whether the hypothesis (b) is tenable.

7) A continuous long glacial cover existed over the north shore of Lake Erie since burial of the 25,000 year old forests, while depositing till (g). The glacial movement was first along the Lake Erie depression, and the ice lobe spread out of it towards the surrounding land. Later on, probably with increase of the thickness of the ice, during the maximum of the Main Wisconsin glaciation, the glacial movement was from NE in the Port Talbot area: it came right across the land disregarding the topographic differences of lake depressions and the higher ground between them. Till was deposited continuously during these changes of the ice-movement in Southwestern Ontario. Similarities in till lithology from the bottom to the top of the till (g) indicate a relatively constant regional ice-flow: it was from N. E. towards S. W. Towards the end of deposition of till (g) the local ice movement was from S. E. again along the north shore of Lake Erie. The ice sheet had become thinner, and it resumed a lobate character, flowing principally along the major depressions. This was a sign of retreat of the glacier.

8) The Erie lobe retreated at least as far as the eastern portion of Lake Erie, as indicated by the regionally persistent textural and lithologic differences between the "lower till" (g) and the "upper till" (h) not only in Southwestern Ontario, but also in Northern Ohio (White, 1951, p. 971; and Shepps, 1953, pp. 43–45). The upper till is considerably more clayey than the lower one, and it is thicker than 100 feet in many places. Such large masses of clayey till must have been formed by reworking of extensive lacustrine deposits that covered the lower till and still cover it in some places. Since the retreat of the Erie lobe for a couple of hundred miles and the following readvance for the same distance, measured along the axis of the lake, required several thousands of years, this oscillation may be considered as an interstadial subage, at least for the Lake Erie region, and therefore called here the *Erie interstadial.* Further studies are still necessary to determine how far and when did the ice retreat, and how this retreat correlates with other areas in the Great Lakes region.

9) The already mentioned clayey "upper till" was deposited by that glacial advance which reached beyond the Defiance moraine farther south west (White, 1951, p. 971). When the Erie lobe retreated, proglacial lacustrine deposits, such as (i) and (k) at Port Talbot, were laid down in front of it in the Erie basin. Several layers of the "upper till" were deposited in areas where the glacial margin oscillated, for instance (h) and (j) at Port Talbot. The layer (j) terminates one mile west of the gyttja exposure, but it may be traced for at least 20 miles towards the east. It seems to correspond to the oscillation that formed the Tillsonburg moraine. All these glacial oscillations and lacustrine activities occurred during the development of the following lake stages in the Erie basin: 1) Lake Maumee, 2) Lake Arkona, 3) Lake Whittlesey and 4) Lake Warren. The top of the Port Talbot exposure (675 feet above sea level) was below the water level of all the above lake stages.

The sequence of glacial and interstadial subages, as postulated by the writer for the north-central portion of Lake Erie basin, is summarized in table 6, together with the index letters of layers, exposed at Port Talbot. This is not considered as a complete and well-proven stratigraphic sequence, but merely a suggestion, open for criticism and comparison with other late Pleistocene stratigraphies of the adjoining areas. Therefore, temporary local terms are used for the substages until it is possible to correlate them with generally accepted stratigraphic names. We are at a stage of re-evaluation of Pleistocene stratigraphy, and every report of progress with certain working hypotheses will assist in building up a more correct stratigraphy of the Pleistocene.

TABLE 6

Proposed Wisconsin stratigraphy for the north shore of Lake Erie, central portion

Number of glacial cover*	Glacial and Interstadial Subages; important events in the Lake Erie basin	Index letters and types of deposts or unconformities at Port Talbot
	Main Wisconsin glaciation	
IV	*Final glacial advance*, and the Maumee, Arkona, Whittlesey and Warren stages of proglacial lakes during the oscillatory retreat of ice towards the north east.	lacustrine clay (k) till (j) lacustrine clay (i) till (h)
	Erie interstadial: *Retreat of the Erie glacial lobe* towards the eastern portion of Lake Erie, followed by a proglacial lake.	unconformity (lacustrine deposits elsewhere)
III	A long-lasting uninterrupted *glacial cover*, but with changing directions of ice movements.	till (g)
	Plum Point *interstadial* wood (reworked) approximately 25,600–28,000 years old.	erosion, unconformity
II	*Glacial advance* from northeast down to the Lake Erie depression, probably beginning the main Wisconsin glaciation.	till and gravel (f) lacustrine clay (e)
	Port Talbot interstadial Ice sheet retreats far north. Cool temperate climate with evergreen forests. Thermal maximum more than 39,000 years ago.	sand (d) silt and gyttja (c)
	Early Wisconsin glacial subage	
I	Extensive glacial cover, followed by a proglacial lake.	varved clay (b) till (a)

*The tills underneath the lake level, representing older glacial advances of unknown age, are not included here.

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APPENDIX

While discussing age of the layer (f), the author did not have any radiocarbon dates for crosschecking the assumed alternatives of approximately 25,000 years or considerably more than 25,000 years (see p. 80). Thanks to the excellent co-operation of K. J. McCallum at the radiocarbon laboratory of the University of Saskatchewan, a splinter of conifer wood, found together with a fragment of a mastodon tusk (see p. 73) was dated recently. Its age was determined to be more than 34,000 radiocarbon years (S–46). The fresh appearance of wood suggests that it was not picked up by glacier from a peat deposit, but most probably derived from a forest, overwhelmed by the glacial advance. Though reworking of old glacial drift is not excluded, lack of abrasion marks on both the wood and the tusk suggest more probably that their age does not differ much from the age of the glacial advance, which deposited the till (f_1). If so, till (f_1) is more than 34,000 years old (see the alternative (b), p. 80), and it represents a glacial advance separating the Plum Point interstadial from the Port Talbot interstadial (table 6). Another radiocarbon date is anticipated on the (S–46) material as a cross-check.

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